ERIC Document Resume	See Instruction Sheet	DATE OF RESUME	DATE RECEIVED

A. PUBLICATION DATA

1. ERIC NUMBER	2. ORIGINATOR CONTROL NO(S).	3. IDENTIFICATION NO.	DO NOT WRITE IN SPACE BELOW
ED002252	N.A.	1447	

4. AUTHOR(S): Tondow, Murray

5. TITLE OF DOCUMENT ABSTRACTED: Electronic Data Processing in Education

6. PUBLICATION TITLE: N.A.

7. EDITOR(S): Charlier, R., and others

8. PLACE OF ORIGIN: Chicago Teachers College-North, 5500 N. St. Louis, Chicago 25, Illinois

9. PUBLISHER OR SOURCE: Chicago Teachers College-North, 5500 N. St. Louis, Chicago 25, Illinois

10. VOL.	11. PAGES	12. MO./YR.	13. TOTAL PP.
2	N.A.	12/61	24

ORG. College-North
ST. 5500 N. St. Louis
CITY, STATE Chicago 25, Illinois
TELE. EXT.
INST/LOC CODE

MICROFILM COPY AVAILABLE: YES ☒ NO ☐

COPYRIGHT GRANTED: YES ☐ NO ☒

COPYRIGHT RELEASE FILED: YES ☐ NO ☐

TYPE OF REPORT: PROPOSAL ☐ IN-PROGRESS ☐ FINAL ☒ FOLLOW-UP ☐

OTHER ERIC REFERENCES:

ERIC SATELLITE CODE

B. INDEXING DATA

14. SUBJECT AREA

15. TYPE OF ENDEAVOR: Report

16. INDEXING TERMS (6-12)

electronic data	history	educational	environment	automation
data processing	school accounting	finances	college records	
instructional technology	scheduling	legal problems		
	student records	computer development		

17. ABSTRACT (MAX. 250 WORDS) Education has been slow in fully utilizing electronic data processing equipment (EDP). Educator confidence in EDP has grown, however, as a result of the success of electronic data processing in science, industry, and other professions. The development of solid state transistorized computers has made powerful desk-size computers a reality and within the budget of many school districts. Funds are available for developing electronic data processing installations and hiring appropriate personnel to operate such facilities as a result of the National Defense Education Act. One of the serious drawbacks a school faces when considering a computer is the problem of programing the machine. Areas for EDP include school accounting, scheduling, reporting, and student records.

Adequate usage of EDP is difficult because of such problems as finances, the question of whether to buy or rent equipment, communication difficulties, legal problems, inertia of educator attitudes, the fear of dehumanizing education, lack of trained personnel, the state of computer development which designs machines before considering specific problems to be solved, and training and staffing considerations.

An example of an automated pupil attendance program is presented. Points of description in the program include purposes, parameters, historical aspects, procedures, and additional implications.

ERIC No.

18. SOURCE OF ABSTRACT

C. FUNDING DATA

19. SUPPORTING ORGANIZATION	20. DIVISION OR DEPT.	21. CONTRACT NO. / PROJECT NO.
	22. TOTAL COST OF PROJECT	
	23. DURATION OF PROJECT	U.S. Department of Health, Education, and Welfare Office of Education

ERIC Form 1

1447

ED002252

INSTRUCTIONAL TECHNOLOGY - U.S.C.

1447

X53

RESEARCH & DEVELOPMENT BULLETIN • RESEARCH & DEVELOPMENT BULLETIN

ELECTRONIC DATA PROCESSING

IN EDUCATION

RESEARCH & DEVELOPMENT BULLETIN • RESEARCH & DEVELOPMENT BULLETIN

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Volume: 2

Date: December 1, 1961

Price: $1.00

J0279

DATA PROCESSING IN EDUCATION

by Murray Tondow

FORWARD

This treatise was developed with two specific purposes in mind:

1. As an introduction to electronic data processing usage in education for those in the profession.
2. As a discussion paper for appropriate education and psychology courses.

This paper is not intended as a "how to" document. Rather its aim is to give a historical perspective to this area of concern and to point up those gender of problems that are peculiar to education. Indeed, the major emphasis is upon viewing education as a unique system, and urging the application of systems concepts as the most effective avenue of approach to those types of problems discussed. While equipment choice and usage is important, it is secondary to a proper systems approach.

M.T.
8/15/61

Table of Contents

1.0	Introduction	Page 1
2.0	Historical Perspective	2
2.1	Techniques and Applications	3
2.1.1	School Accounting	3
2.1.2	Scheduling and Reporting	3
2.1.3	Student Records at the College Level	5
3.0	Educational Environment	5
3.1	Financial	5
3.1.1	Service Bureau - Data Center - Rental	6
3.1.2	Peak Loads	7
3.1.3	Communication Difficulties	7
3.2	Legal Problems	7
3.3	Educator Attitudes	7
3.3.1	Fear of "Dehumanizing" Education	7
3.3.2	Lack of Trained Personnel	8
3.3.3	Present State of Computer Development	8
3.4	Uniqueness of the Educational System	8
3.5	Training and Staffing Considerations	9
4.0	Example of An Automated Pupil Attendance Program	10
4.1	Purpose	10
4.2	Parameters	10
4.3	Historical Aspects	11
4.4	Procedure	11
4.5	Additional Implications	14
5.0	Final Considerations	14
6.0	Bibliography	16
7.0	Appendix	
7.1	Flow Diagram of An Automated Pupil Attendance Program	18
7.2	Chart Comparison of Manual and Automated System	19

1.0 INTRODUCTION

This paper presents an overview of the roles of electronic data processing in education. As used here, "electronic data processing" (EDP) includes punched card methods; an electromechanical, rather than electronic, technique. This broad definition is necessary because much (if not most) of the present automated data processing in education centers around punched card methods. Electronic computers are just beginning to be utilized, and by including punched card methods, this discussion will encompass a much broader picture of the EDP development in education.

Much has been written about the contemporary problems of American education. For the purpose of this paper, the following two issues will suffice as appropriate examples.

Since the turn of the century, man has increased his knowledge at an ever accelerated rate, perhaps even doubled his knowledge. An educated man of the 17th century who could have returned to the world of the late 19th century would not have been at a loss to understand what he saw; but a person viewing the world of today after only a 50 year absence would be unable to comprehend its sights and sounds. (For a dramatic example of just such a real-life experience, the reader is referred to the autobiography, "I Leap Over the Wall".) [2]

It is estimated that 90 percent of all the scientists of all time are now living. There is no reason to believe that these people are any less skillful or talented than their predecessors. Indeed, they are probably better educated and certainly have superior facilites with which to work. This statistic strongly supports the contention that information can be expected to emerge and form the basis of more knowledge at even more accelerated rates than previously. The problem this situation raises for education is quite serious; althought the amount of material to be taught has increased, the time period in which to do the job has not. Further, the teacher must be prepared to teach a body of information, much of which has been discovered or developed subsequent to conclusion of his or her training. How many of us received any education in digital computers, rocketry, or nuclear physics in high school or college?

Along with the increase in mankind's knowledge, has been the explosive increase in population. Experts in the field tell us that today's population represents 20 percent of all people born in the last 2000 years. The trend remains unchanged. Hence, there are and will be, more students; and new and bigger school districts will come into being.

Education must face these issues with courage and ingenuity. To help meet the problems of teaching an ever increasing amount of material, we must make more efficient use of teacher time. Many educators claim that one-third or more of a teacher's time is spent on nonteaching duties. For the growing school district, more effective methods of management and administration are necessary. In both these cases electronic data processing offers a rich potential in reaching functional solutions.

The computer is a tool to be utilized in education; a tool whose prospects in aiding the behavioral sciences parallel those of the microscope in aiding the biological sciences. We must understand and properly utilize its potential capabilities.

2.0 HISTORICAL PERSPECTIVE

Education has been slow in fully utilizing electronic data processing equipment. The following paragrapns describe several factors which indicate that education is now expanding its utilization of electronic data processing equipment and suggest some reasons for the change.

The field of education is "ready" to accept the assistance of EDP, due to the pressures of the problems already discussed in this chapter as well as others that education now faces. Educator confidence has grown as a result of the success of electronic data processing in science, industry, and other professions, and its contribution to education when it has been used.

The increase in the number of machines available has been very rapid. In 1959, alone, the number of computers in operation increased by 75 percent. In addition, the variety of computers has also been increasing at a rapid rate: from a half dozen or so in the mid '50s to over 60 different kinds and 300 models in 1960. Consequently, both purchase and rental costs of the equipment tend to become more competitive.

The development of "solid state" transistorized computers has made powerful desk-size computers a reality. These small machines are well within the budget range of many school districts. The increased number of machines also means that information is available concerning use of the equipment, which is quite helpful to school personnel and school boards when studying the possibility of obtaining or using such equipment.

As a result of the National Defense Education Act, funds are available for developing electronic data processing installations and hiring appropriate personnel to operate such facilities. Perhaps as important as the funds are the leadership and assistance furnished by the U. S. Office of Education.

Because the education market has been barely scratched in the field of electronic data processing equipment, "hardware" manufacturers offer attractive discounts to educational institutions.

Electronic data processing equipment is a part of contemporary society. People must be trained in how to operate these machines. The needs in this field range from the high school graduate to the person with a doctorate. Some high schools and junior colleges, as well as colleges and universities, are installing and using their equipment for training students as well as serving administrative needs of the institution.

One of the serious drawbacks that a school faces when considering a computer is the problem of programming the machine. Educational problems tend to be complex and usually require highly skilled programmers. "Translators" and "compilers" are recent programming developments that reduce drastically the need for the person writing the instruction to know the details of the machine or its "language". With compilers a person need only write his problem in logical sequence in the language of his profession. The imminent availability of such tools promises to permit school personnel, who are not computer experts, to utilize these machines. As we increase the number of users so will we increase the contribution and importance of computers to education.

2.1 Techniques and Applications: The earliest bibliographical material available concerning mechanical data processing in education appears to be the Baehen[1] book on Hollerith machines, published in 1935. Specific data are available concerning the use of this approach toward the problems of college registration, general administrative problems and research applications.

While marginal-punched cards are not used for electronic data processing, they are employed by many schools. For a description of this procedure the reader is referred to Punched Cards: Their Application to Science and Industry by Robert Casey.[5]

2.1.1 School Accounting: The use of punched cards in school accounting apparently dates back to at least 1924.[17] Schools using such equipment apply it in a wide variety of jobs, such as printing (warrants, invoices, etc.), inventory and register maintenance, accounting statement preparation, student registration, and attendance records. No two school districts have exactly the same program. Payroll procedures exhibit the greatest degree of similarity.

Most schools using machine accounting seem to be satisfied. The most common reasons to be noted are:

a. machine techniques save time;
b. they result in greater accuracy;
c. the data are readily available for various reports; and
d. they offer financial savings.

Some disagreement exists about financial savings. Apparently, the system changed from and the system changed to[4] determine whether an actual saving is effected. The definition of "financial savings" must also be considered. For instance, there seems to be general agreement that floor space is saved and fewer file cabinets are needed. This can be considered a financial saving.

In the literature referenced in this paper, some 22 evidences of dissatisfaction with machine accounting were noted. Of these only one comment occurs in any significant number of places: namely, the difficulty in obtaining competent personnel and relative high cost for such people. While raising a serious problem for schools, this difficulty is not a failure of the machines.

A comprehensive survey of machine accounting is to be found in the May 1958, issue of Nation's Schools.[15]

2.1.2 Scheduling and Reporting: Unlike accounting (for which techniques developed in industry can be modified and applied), scheduling and reporting represent a challenge unique to education. While the development in this area has been long (since 1935[16]) and slow, educators have had to lead the way, and the problems encountered here are by

no means simple. Indeed, some of the most complex machine problems we face in educational utilization of electronic data processing equipment are in the area of student scheduling and attendance reporting.

While educators express a satisfaction with machine methods, automation in this area has been resisted. Generally this reaction relates to an uneasiness at being totally dependent upon machines for scheduling. In some cases this is probably due to unfamiliarity with equipment, in others it may relate to a feeling that machines "dehumanize" the scheduling process, and in still other instances it is merely inertia to change. For example, one article [7] states: "The reason we are continuing to post grades manually is because it is the principal task for a number of school office workers that are employed on a year-basis."

Contrary to fears that machines will "dehumanize" scheduling, the opposite actually is true. Electronic data processing equipment makes possible the most completely individual approach, since the speed of the machines permit all possible combinations to be developed, resulting in the best "fit".

Advantages of automating scheduling and reporting, as noted in the literature, are:

a. reduction in error,
b. facilitation of the entire pupil programming procedure,
c. saving in human energy and nerves (perhaps the most important factor),
d. provision of desirable ancillary services, such as printed class lists, at no increase in cost or effort.

The negative factors (summarized from references 8, 9, 10, 12, 20, 21) include the expense of the equipment--either purchase or rental--and the high installation cost. The criticism is probably less valid now. The newer equipment is reasonably priced and simpler to install. Also the manufacturer's introduction of new computers can be expected to make older equipment available at considerable savings.

A very common misconception is that use of electronic data processing equipment automatically reduces personnel requirements: this is not necessarily so. There is still the big job of paper handling before and after the machine processing. Indeed the speed and versatility of the equipment usually results in increased services and the production of more paper than before. In addition, specially trained people must be hired to operate the machines and program the computer. The savings which result are primarily in labor rather than personnel. That is, clerical and professional personnel are freed from much drudgery and can now be used on more productive and personally satisfying tasks.

Personnel savings may be realized as the system expands. That is, as the school system grows, the previously unused equipment capabilities makes it unnecessary to hire additional people at the same rate as before. However, in considering personnel costs, one must take into account the fact that it is necessary to either hire expensive personnel to use the equipment or to train personnel to do so. After training, the individual has skills that are highly valued and marketable. Unless adequately compensated, he can be lost by the school to industry.

"Equipment itself occupies valuable space." This criticism is also open to question. As stated earlier, the newer pieces of equipment require very small space for the labor performed. In addition, space is saved because fewer file cabinets are necessary.

2.1.3 Student Records at the College Level: Machines have apparently been used in colleges prior to their use at other educational levels.[11] Several reasons can be postulated for this "early" usage:

a. machine utilization and computer facilities represent a status symbol for the institution;
b colleges and universities have some staff personnel who are familiar with such equipment and can offer important assistance; and
c. computers are an important research tool, and research is a basic responsibility of higher education (the equipment is used for research, which in turn is a source of financial support for the equipment).

The range of functions to which the equipment is generally put to use include such things as admission, registration, grade reports, permanent records, statistical reports, and test data. A more detailed breakdown of how these problems are handled by electronic data processing equipment can be found in references 3, 6, 12, 13, 14, and 18.

The use of the workshop technique has been quite popular in sharing progress and problems concerning computer applications among college and university people. Most commonly, conferences deal with rather specific problems. This would seem to be natural and desirable since the field is really quite new and the computer sciences are developing so rapidly that to rely on the literature alone is to rely on information that is often obsolete by the time it is published.

3.0 EDUCATIONAL ENVIRONMENT

The adequate utilization of EDP in education is not an easy task. What makes machine usage in education difficult? The following list is not presented in any given order of magnitude for it is impossible to set a priority ranking. Each situation is different and the relative importance of any factor varies from situation to situation and in time within a given situation.

3.1 Financial: Whenever "money" arises as an issue, it is important regardless of what other difficulties may have to be overcome. EDP requires equipment. This equipment puts a minimum initial cost burden upon the school regardless of the extent it is used. To avoid this large initial outlay of funds, schools can contract for EDP equipment and services from a service bureau. But, when this occurs, the school loses control. For example, the scheduling of the school's data processing requirements is controlled by the service bureau. They try to meet the request of the school, but the school is not their only customer--and generally not the largest user. Further, most educational work is "peaked"; that is, it all comes at the same time. This often means overtime with the resultant cost increase to the school.

In addition, experience has shown that more errors are introduces when the work is performed outside the educational environment. This problem, it is hoped, may disappear as special educational service bureaus--as distinct from business service bureaus--become a reality. These bureaus will be staffed by individuals who understand both the equipment and the special problems of automated data processing for education. There is no greater problem in all EDP than that of communication between the operator of the equipment and the user of the data. This is not to imply that a school installation is better than a service bureau arrangement. Rather, each has its own set of problems (as well as values). The educational service bureau concept seems to be evolving at the state level through state departments of education; in big city systems; and to a lesser degree on a regional basis such as county and metropolitan areas. As mentioned earlier, funds are now available to assist schools in these endeavors through the National Defense Education Act.

The fact that electronic data processing involves the use of expensive equipment means that the traditional approach in education of any number of people working on a problem in their "spare" time is not possible. For all its speed and versatility, the computer is rigid. Once a program is written and input and output formats are decided upon, one must work within the constraints of these rules. Each teacher, counselor or administrator cannot "solve" the problem in his own way. The computer program follows a series of minute sequentially logical steps. In this form of communication, each term is carefully and completely defined and must be adhered to without variation.

A very vital quality of service bureaus is that costs can be amortized over a number of school districts. This includes the sizeable research and development effort necessary before one can start any service. Another possibility is that of maximum use of the equipment (more than one shift), reduces cost per job. One must also keep in mind that with the service bureau the school does not need to find space for equipment, does not need to hire machine operators, and there is no equipment that can become obsolete.

The three very important problems that were discussed in this section are summarized in the following paragraphs.

3.1.1 Service Bureau Versus Equipment Rental or Purchase: There is no one right answer to the question of whether to buy or rent equipment. In many situations, it may be desirable to have some equipment and use service bureau time on expensive components when necessary. Indeed, a third alternative is just now beginning to become available; the data center. The data center differs from the service bureau in that the user does his own programming and preparation and merely rents time on the machine--something like the laundromat. Because no staff time is involved (as in the service bureau) the use of data center is relatively inexpensive, but the user must do all the "think" work. In some locations the customer has the opportunity to use the facilities either as a Service Bureau or a Data Center.

3.1.2 Peak Loads: Unlike business--where jobs, such as sales reports can be spread out over a period of time and scheduled so as not to conflict with other work, most educational work must be done at a given time (for example, specific state reports) and schools cannot change the due date so as not to be in conflict with the schedule of other schools or other work within the school (such as report cards).

3.1.3 Communication Difficulties: The difficulties in communication that seem inherent in EDP utilization at the present time are a major problem and will be further discussed (in Section 3.4) as will that of the concomitant problem of staff (in Section 3.5).

3.2 Legal Problems: Anyone who has worked in this field must come away impressed (often dismayed) with the myriad of legal controls constraining educators. Implicit in this situation are a body of problems hindering universal reporting systems and procedures which precludes optimization of the use of computer equipment. Legal requirements (for example, recording attendance by grade, sex, and half day), tend to slow progress in EDP and may even increase unnecessarily the cost of its use.

3.3 Educator Attitudes - Inertia: One of the more formidable phenomena that any new endeavor in education faces is that of inertia. This is not in and of itself bad. A profession should not adopt every fad that occurs; the new concept should prove its worth first, preferably through controlled experimentation. If education has a great deal of inerta, it can be attributed in large part to the traditions and structure developed through long life and the extensiveness of education in the United States.

In the U.S. , teaching is easily the largest profession including, as it does, thousands of teachers and millions of students. The concept of free and universal education has been part of the American tradition since our earliest times and through the years we have steadily (if slowly in some cases) been moving toward its realization. The magnitude of education thus contributes to its inertia.

One result of the tradition of local autonomy and universal free education is that people are very closely involved with education, and often retain a lifetime interest--having been pupils, later parents, and always tax payers. Local autonomy affects and influences the attitude of educators and their reaction to new concepts in education.

3.3.1 Fear of "Dehumanizing" Education: One very common concern often voiced by educators, particularly specialists in counseling and guidance, is that the use of machines will defeat one vital goal of education: that of concern for the individual. In a word, they fear it will dehumanize education. The contrary is true. The ability of the computer to handle large amounts of data and compare many variables results in more detailed and accurate information about the individual. Nevertheless, one hears such statements as "You can't classify individual variables the way the computer requires." Experience has shown conclusively that we can.

3.3.2 Lack of Trained Personnel: The answer to this problem, and the problem of staffing in general, would seem to lie with the training of new people. Their preparation should include exposure to the potentials and achievements of the latest scientific advances. This is a problem that obviously goes beyond computer utilization. One of the difficulties is that most university professors responsible for the formal preparation of educators were themselves trained before the advent of these scientific achievements. The high speed stored memory digital computer is not yet 15 years old. The rapid rate of scientific movement means that education must be considered a continuous lifetime activity, most particularly for those who are to be responsible for the education of others.

To properly utilize electronic data processing equipment, a well trained staff is necessary. This will require an extensive and intensive in-service training program. This is a formidable task, but without trained personnel, the system cannot operate. To begin operation prematurely, with incompletely checked programs, and with inadequately trained personnel has serious consequences, for a failure in any school system makes more difficult the task for all districts.

3.3.3 Present State of Computer Development: Somewhat tangential to the problems already mentioned is the consideration of the present state of the computer services and equipment. In this field, basic discovery has been followed by applied development, manufacture of a new computer, and finally the search for problems that the computer can solve. However, a more desirable sequence would be: study and definition of the problems--in this case educational problems--followed by manufacture of equipment to solve the problems. It is suggested that more effort be put into the system analysis of education leading to the development of special-purpose equipment. By definition, general-purpose computers must be less economical to operate in the solution of given special problems or services. The position taken by some equipment makers that the problems of education are similar to those of business seems to have only face validity, and even this is questionable. If the demand is made vocal, manufacturers will eventually produce computer equipment specifically designed to meet the needs of education.

3.4 Uniqueness of the Educational System: To consider education in a system context introduces the major problem of analysis and understanding. Principal efforts in systems work have been oriented toward military applications. Those who have had some experience in both military systems and educational research are inclined to believe that education, at least for the purposes of system analysis, is more complex than the military. In the military, for example, the line of command and the responsibilities at various levels are clear and uniform. This situation is not true of education; titles can mean anything--or nothing--in education. The system is full of "noise"; pressure from parents, community, school board etc., all tend to confuse the effort.

In addition, we have subsystems in many dimensions:

a. size: small, medium, large;
b. type: rural, urban;
c. level of education: elementary, junior high school, high school, junior college, college, university;
d. level of administration: local, regional (such as county), state, federal;
e. type of responsibility: line, staff, administrative, supervisor, consultive; and
f. others:

All these interactions make careful study extremely difficult.

Every system must, by definition, have a goal. Try to get a single clear and concise statement of goals from a dozen educators, or for that matter six: for purposes of emphasis, try it with three! This is not to say that education has no goals, but it is difficult to arrive at a concise acceptable formulation of these goals. One of the reasons for this difficulty has to do with the very language of education, which is not always precise. At any rate these special considerations serve to make education a unique, loosely structured system. It is therefore difficult to apply the precise, highly organized, and routinized procedures of electronic data processing to educational data. It is difficult, but it is a challenge that is being met.

3.5 Training and Staffing Considerations: This is a serious problem and made more so because of the newness of the computer sciences and the dearth of academic opportunities for gaining experience in this field. The author knows of no institution in the country that offers a degree in computer sciences. The interested individual is limited to isolated courses. Such training leaves the student with an uneven background. Training in education should include training in, and use of, EDP. With few exceptions, (such as Robert Traver's [22] book), texts concerned with educational research have little or nothing on the computer sciences. We will not adequately include this important tool in the academic program unless we have text books and sufficient courses to assist.

Perhaps because of the research aspects of the work; perhaps because of the more advanced utilization of EDP in psychology and sociology; perhaps because of training; and probably because of all three, the school psychologist is, at present, the leader in new methods of EDP utilization in education. The opinion has been expressed that EDP is developing a paraprofession--a group of individuals specially trained to integrate EDP into the behavioral sciences. The author believes such a condition now exists but that this will change as new graduates, trained in computer usage, enter the behavioral sciences.

The present shortage of people skilled in electronic data processing applications and the very strong demand for such skills, both in and out of education, have combined to create another serious problem: salary. Because the individual who is trained in education and skilled in computers is usually "young" another dimension is added to the salary problem. Traditional school salary schedules are rarely competitive with industry. Deviation from regular salary schedules introduce moral problems among some staff members. To employ the proper person, such deviations are often necessary, and any difficulties that may arise because of salary must be faced.

Many of these problems of staff can probably be considered transitory. Training will help alleviate them. Also, as time goes on, the equipment will become more sophisticated and easier to understand and use, which should result in a wider base of users.

4.0 EXAMPLE OF AN AUTOMATED PUPIL ATTENDANCE PROGRAM

The automated system program presented here illustrates many points discussed in this paper. It emphasizes an axiom of modern science that each factor must be viewed as interacting with many other factors, despite the fact that each factor is discussed as a separate entity.

A common fallacy is to view a mechanized program as synonomous with automation. This is not so. This example has to do with pupil attendance, of which there are many mechanical programs, but few automated systems. The mere usage of a punched card does not mean the system is automated.

The system to be described was developed as the first phase of a planned automated and integrated pupil personnel system. (Those who worked on this system, in addition to the author, included Gene Callahan, Velma Veneziano, James Williams, Michael Fein, Albert Briggs, and Irene Noch.)

4.1 Purpose: The purposes of automating pupil personnel record handling in this case can be summarized as follows:

a. to reduce the paper work to which the teacher is subjected;
b. to increase the speed at which the final district reports are prepared;
c. to make attendance information more readily accessible and available for any special reports requiring such data; and
d. to improve decision-making capacity at top administrative level.

4.2 Parameters: The program must provide for the following parameters:

a. sample size (approx.): 400,000 elementary school students, 400 schools, 15,000 teachers;

b. legal: attendance must be taken on a half-day basis and
c. educational: the teacher must have some record of pupil attendance in the classroom at all times.

Processing data of the order of magnitude indicated by the sample size parameter requires large scale computer equipment. The legal requirement of half-day attendance reporting doubles the internal computer operation requirements and adds to the complexity of the programming logic. The fact that the teacher must have some attendance document available at all times requires some form of duplication (in this case carbon copies) since the original forms must be removed from the school for processing.

4.3 Historical Aspects: The pressure of constantly increased enrollments; the need to make decisions often without adequate data; plus the heavy burden of paperwork upon teachers led the school district to explore the possibilities of computer utilization. The school hoped ultimately to utilize computers in the widest possible range of school functions. Pupil personnel was selected as the area for study and possible first implementation.

4.4 Procedure: It should be emphasized that this system represents one solution to a specific problem. Others may have resolved the problem differently. There is no attempt to claim superior qualities for this program. The general concept of this approach submits to generalization, but considerable modification of these procedures would be necessary to apply the approach satisfactorily to other school systems.

In order to adequately study the problem, it was necessary to have a "laboratory." The school selected met three requirements deemed necessary:

a. administrators and teachers supported the study;
b. the school had more than the usual number of problems so that difficulties and exceptions could be dealt with from the very beginning; and
c. the plant was large enough that our pilot experience would not be too simple (school population was approximately 2,500).

There was very strong consensus among the school staff that attendance be the first problem studied in the area of automating pupil personnel procedures. The teachers considered this a particularly onerous task. From the standpoint of evaluating EDP in education, it afforded early feedback and positive reinforcement to the teacher. This was felt to be important, because later phases of automation would require teacher support without any noticeable benefits to the teacher.

The pupil personnel system was studied with particular emphasis upon attendance procedures. School forms were analyzed as to number and usage. Existing pupil personnel forms appeared to contain, as is common, a degree of redundancy allowing eventual elimination of two thirds of the forms. Information flow was studied with respect to decision points, timing, and degrees of freedom within the system.

The preliminary system design represented a minimum change over the existing manual system. In order to develop adequate quality control some check had to be made at the school since there would eventually be many schools involved and the more immediate the feedback the more efficient the system. The school clerk, an experienced paper handler, filled the need for this early point of quality control. It might be noted that the idea of using the school clerk for this sensitive duty came about as a result of a thorough knowledge of the school culture and the role of the school within this special environment. Since this system would eventually handle all pupil personnel data, a permanent coding system was developed. A 10-digit number was assigned permanently to each pupil. Record updating, storage, and retrieval would be computer functions. Records for 25,000 pupils could be stored on one reel of magnetic tape.

Because of the magnitude of the eventual system and the emphasis on data look-up and data movement, a large scale data processing system (as compared to a scientific computer) was determined best. Because of the problem of peak loads and many source documents, the preparation of data for the equipment was a major problem. Traditional key punching would be inadequate within the time available. In order to pack as much data as possible on each source document, an optical scanner that would handle an 8-1/2" x 11" sheet of paper was selected.

For a time Porta-punch cards were seriously considered. Two school forms were designed, one to record attendance and one to record all pupil changes (from class to class, leaving school, entering school). Each attendance form handled the information on 30 youngsters for a week. The teacher marked only by exception, that is, when the child was absent or tardy.

It has been the author's experience that in almost all projects concerned with man-machine systems, two things invariably occur: 1, the project turns out to be more complicated than anticipated, and 2, serendipity is manifest.

In this district the attendance reports were on a four week basis and report cards on a five-week basis. The teacher had to compute attendance figures both times. To completely eliminate her need to compile attendance totals, computer computations would have to be made for both the monthly report and the five-week report card. This more than doubled the data processing involved. Teachers spent a great deal of time making class rosters throughout the school year, and the school clerk spent a good deal of time compiling a locator file, and was constantly updating it. This file consists of a card for each child, containing name, grade and room number. The total amount of data on a card varies with each school but the three bits mentioned were common to all schools in the district. With a minimum of effort, we were able to supply each teacher with all necessary class rosters and the school clerk with a locator deck of printed IBM cards.

The pilot run of the new system was five weeks in duration. Because many changes were expected, computer operations were simulated with EAM equipment.

Finally, the pilot experiment was analyzed and appropriate modifications made. The following paragraphs summarize the conclusions drawn from the experimental results.

One major difficulty arose due to errors by the teacher in preparing the original attendance classification. There were 14 such classifications. This was resolved by reducing to five the number of symbols the teacher had to handle (A - absent, H - holiday, RCV - receive, LV - leave, T - tardy). It was necessary to retain the other nine symbols for report purposes, and this was done within the logic of the computer program. For example, if a pupil was absent three consecutive days he must be recorded as WT (withdrawal). This was handled automatically by the computer.

The packaging of the materials was inadequate to the wear and tear of everyday use. The cover was redesigned,

Teacher reaction indicated a subtle but powerful resistance. For example the teacher was requested (in writing, in three different places) never to use a ball point pen in marking the attendance form. The number of ball point marks can be interpreted as subconscious (if not overt) resistance. A more adequate orientation discussion with teachers was planned.

Results of the second pilot experiment, run with the modified system, indicated a significant decrease in human factor errors and a very strong satisfaction among the participating teachers. At this point, final program debugging is necessary. The system can then become operational. Figure 7.1 illustrates the essentials of the system.

An evaluation of the proposed automated attendance system, by school personnel, verified the reduction in clerical work at the level of teacher, school clerk, and district office and established that, at all levels, an attitude of sincere willingness to try the new system prevailed.

School personnel estimated time saved at two hours per teacher per month. Considered on the total school system of 15,000 teachers this would mean some 30,000 additional teacher-hours available each month for educational activity.

Clerical work for the school clerk was estimated by school personnel as being reduced by 20 hours per month per school. Based on the total of 400 schools, this would mean a saving of 8,000 hours per month.

It was estimated that clerical work at the district would be significantly reduced, though no time accounting was attempted. The chart on page 19 compares the manual system with the automated system.

4.5 Additional Implications: The pupil code number and the storage and retrevial procedures developed for the attendance system represent the base for a complete pupil personnel system. While obvious modifications are necessary as more functions are added, we essentially add more data to each pupil (code number) in the same manner as with attendance data.

The attendance system contains 2/3 of the necessary data for the automated report cards; name, grade, teacher, and attendance information. As a result the cost to add automated reports is quite small.

The more we store on magnetic tape (in this case) the fewer forms are needed in the school. This would eventually reduce the number of dead files in the schools, as well as floor space necessary for file cabinets.

After automating report cards there should be no major obstacle in developing an automated cumulative record which would be updated each semester.

5.0 FINAL CONSIDERATIONS

We are living in a time of great change, and education is the main channel through which all such changes must pass to have a broad social effect. The computer sciences are a major tool by which education can adjust to meet the new challenges. The school of tomorrow will probably be a totally different entity, in so far as operation is concerned, from todays' institutions. This "new" school is vividly described in an article by Dr. Simon Romo.(23) The important part to remember in reading his article is that all he foresees is now technologically possible. What new technological break throughs as yet unrealized, will do to education, we can only speculate. For example experimental work now going on using electron beams may result in inexpensive compact portable computers. The implications of such equipment to education are enormous.

The problems of education are complex, multi-causal in nature; and require the skills of many disciplines for appropriate action. EDP can not change the nature of the problems, but it can help make many problems that were in the past, impossible to solve now possible of solution. One such problem that much attention has been given, and which is of prime importance for everyday operation as well as for opening possibilities of systems analysis of education on a broad base is that of making data comparable. Please note we did not say make all data the same, rather we want to have data and coding in a form capable of being compared with similar data from any other educational institution. The U. S. Office of Education has been much concerned with this problem in the last several years, and has been a leader in this area.

The field of testing has not been touched upon in this chapter simply because it is an area unto itself. Much has been done in this field utilizing EDP, and one could hardly do more than distort the picture by attempting to condense such material in a chapter of this size. Suffice it to say that some projects already in operation may well make standardized testing as we now know it obsolete. The interested reader is referred to the Peabody College Project sponsered by the Ford Foundation as an interesting example of work in this field.

We have concerned ourselves, in this paper, primarily with EDP applications. Whole areas of theoretical research will certainly have direct impact upon education. Such projects as brain simulation have obvious implications to learning and education.

It appears to the author that the computer sciences open vast areas of positive challenge to the educator interested in new dimensions of education. The limits would seem to be the extent of our courage, energy, and imagination.

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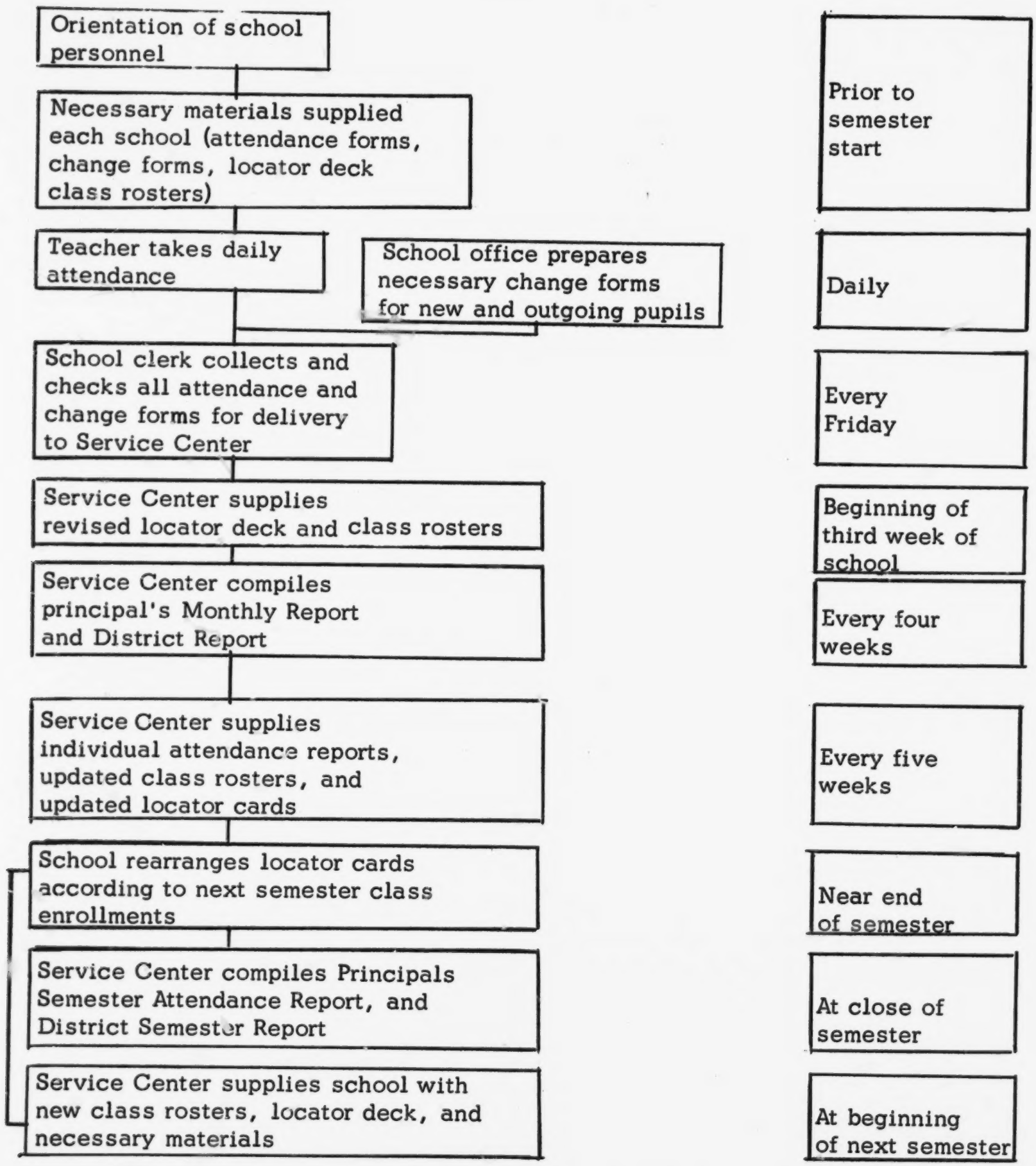
Orientation of school personnel
Prior to semester start
Necessary materials supplied each school (attendance forms, change forms, locator deck class rosters)
Teacher takes daily attendance
School office prepares necessary change forms for new and outgoing pupils
Daily
School clerk collects and checks all attendance and change forms for delivery to Service Center
Every Friday
Service Center supplies revised locator deck and class rosters
Beginning of third week of school
Service Center compiles principal's Monthly Report and District Report
Every four weeks
Service Center supplies individual attendance reports, updated class rosters, and updated locator cards
Every five weeks
School rearranges locator cards according to next semester class enrollments
Near end of semester
Service Center compiles Principals Semester Attendance Report, and District Semester Report
At close of semester
Service Center supplies school with new class rosters, locator deck, and necessary materials
At beginning of next semester

7.1 - Flow Diagram of An Automated Pupil Attendance Program

Manual System	Automated System
Teacher	Teacher
Marks attendance each half-day using 14 symbols.	Marks attendance each half-day using 5 symbols.
Makes numerous class lists throughout the school year.	Service Center supplies (4 copies) updated class lists every 5 weeks.
Computes attendance figures (by sex and grade) every 4 weeks; transcribes to teacher's monthly attendance report.	No longer necessary (now an internal computer function).
Computes attendance figures (for each individual) for report cards every 5 weeks.	Individual attendance report is furnished by Service Center every 5 weeks.
School Office	School Office
Prepares enrollment and transfer forms for all incoming and out-going students. Also arranges for transfers within schools.	Fills out change forms.
Computes attendance figures from teacher's monthly attendance reports; transcribes to principal's report.	Service Center does principal's monthly report every 4 weeks.
Prepares and keeps up-to-date a locator file of pupils for school.	Service Center furnishes locator cards every 5 weeks.
Computes and prepares principal's semester report.	Service center produces principal's semester report.
District Office	District Office
Prepare district-wide attendance data, and special attendance reports.	Service Center supplies all such dates.

7.2 - Manual and Automated System Compared